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Computerized Axial Tomography (CT) Scanners are high dollar items presently authorized at all US Army Medical Centers where workload has justified their acquisition. No Army medical treatment facility smaller than a Medical Center has a CT Scanner. This study attempts to determine whether Darnall Army Community Hospital, Ft Hood, Texas, can document sufficient need to procure a whole body CT Scanner. As a baseline for the study, the National Guideline of 2500 patient examinations per year (or 208 per month) to justify a CT Scanner was used. Average monthly procedures performed on original Darnall patients at civilian or military medical facilities approached 110 to 120 per month-significantly below the baseline. The author did not recommend procuring a CT Scanner, but suggested that a survey be conducted again at a later date after physicians become thoroughly educated on the diagnosing capabilities and advantages of this piece of equipment.

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AN ANALYSIS OF THE NEED FOR A WHOLE-BODY CT SCANNER AT US DARNALL ARMY COMMUNITY HOSPITAL

A Problem Solving Project

Submitted to the Faculty of

Baylor University

In Partial Fulfillment of the

Requirements for the Degree

of

Master of Health Administration

by

Captain John R. Kerrigan

May 1980

TABLE OF CONTENTS

1. INTRODUCTION

General

Medicine has enjoyed the use of radiographic technology since shortly after the discovery of the x-ray and its capabilities by Wilhelm Roentgen in 1895. Rapid improvements in radiographic equipment have been witnessed in the last several decades. In 1967 a significant technological advancement was made with the development of computerized axial tomography or CT. Computerized tomography experiments "were conducted by Godfrey Hounsfield at Central Research Laboratories, EMI, Ltd. in England."[1]

Since those early days the "growth of CT appears to have taken quantum jumps ...."[2] Although the initial impetus was with head scanners, increased validation of clinical applications for whole-body scanners has led to their dominance in the current market field. It is also important to note that the current market is not so much the large, teaching institutions, but community hospitals of 200 or fewer beds.[3]

Born in the days when health care costs were beginning to rise significantly, computerized tomography has developed in the days when national attention has focused on the rising costs for

health care. It has probably been unfairly singled out as a primary example of the technological impetus to raising costs. CT is a matter of public attention and debate and the mere mention of its name among health care planners is surely to illicit response.

Medical treatment facilities within the Department of Defense are not totally immune from the repercussions of this national debate. Applications for large dollar items such as CT scanners must go through the bureaucratic system civilian institutions must address, and meet many of the same requirements as civilian institutions. Presently all medical centers in the US Army are authorized a CT scanner. Their importance to current state-of-art diagnosis is recognized and the workload generated at medical centers has justified their acquisition. However, no scanner has been authorized for any hospital smaller than a medical center. It does not appear that this is a matter of policy, and perhaps if sufficient justification were produced, an Army community hospital could obtain one. The examination of this justification is the purpose of this paper.

Statement of the Problem

The problem is to determine whether sufficient need for a CT scanner at the Darnall Army Community Hospital can be documented and authenticated.

Research Methodology

The capabilities of the whole-body CT scanner were researched through extensive literature review and discussion with physicians

and technicians who have used the equipment. Through an education program this information was presented to the clinical staff and a survey conducted to obtain defendable workload data. This data was used because historical workload data did not appear to capture all potential procedures.

Once all the workload that could be justified was obtained it was compared to the criteria established. The "bottom line" of this comparison was to decide whether sufficient justification existed to develop an economic analysis as the second step in applying for a CT scanner.

History of Darnall Army Community Hospital

US Darnall Army Community Hospital (DACH) was opened in April 1965. It was originally designed to support a total population of approximately 40,000. Almost immediately after the workload study for this hospital was performed, the post population increased dramatically. Despite this fact, the design concept remained the same, with clinical and nursing unit facilities to support a one division post. Presently, Fort Hood is the home of the III US Army Corps, the 1st Cavalry Division, 2d Armored Division and other tenant units. The estimated total supported population is over 150,000.

In May 1979, ground was broken for a 47.7 million dollar addition and alteration project for the hospital. It will add an additional 272,985 square feet to the facility, and upgrade over 221,000 square feet of existing space. Once completed, this project will

greatly increase the hospital's clinical capabilities.

Paralleling Darnall Army Community Hospital's growth in physical size has been a steady expansion of the sophistication of the medicine being practiced. For instance, numerous affiliation programs, with both military and civilian hospitals, have been instituted for medical residency training. Additionally, this July an in-house residency program will be initiated for training in emergency medicine.

Over the last twenty months, extensive effort has been made to obtain a nuclear medicine service. This effort will be completed when the new nuclear medicine clinic opens in May of this year. Additional accomplishments which have increased the diversity and caliber of medicine at Darnall Army Community Hospital include the opening of two family practice clinics; identification of modern, state-of-the-art diagnostic equipment for the expansion and renovation program; approval for a computerized central appointment system and investigation into computerized patient admissions and dispositions; and filmless x-ray storage and presentation.

Present Situation

Patients who require CT scans now are being sent to Scott and White Memorial Hospital in Temple. Since this requires travel, time, expense and patient inconvenience, only those scans which are absolutely essential are performed. Until recently, this facility only had a head CT scanner.

Scans performed at Scott and White Memorial Hospital cost on the average of $250.00 per scan. The current average of about 75 scans per month means this hospital spends about $18,750 a month. This does not include the costs related to transportation and lost duty time. It does not address the problem that Arnold Relman pointed out in an article in Medical Care Review:

> Often the transportation involves patients in pain and those whose medical problem makes them nauseated or uncomfortable, and they may develop life-threatening emergencies in the x-ray department ... Accordingly, when a patient's condition is precarious ... and often when it is not ... doctors or nurses accompany the patients in ambulances. The costs involved often are overlooked. Sometimes CAT scan examinations cannot be made at all because the medical condition precludes transporting the patient elsewhere.[4]

These 75 scans per month do not include the scans requested by Brooke Army Medical Center on patients transferred there. Since BAMC does not have a CT scanner, patients are not sent there expressly for that purpose. Therefore, a scan ordered by BAMC, is not statistically recorded here.

Additionally, all the workload documented for scans performed at Scott and White Memorial Hospital were head scans (Scott and White did not receive a whole-body scanner until February of this year). Moreover, almost 90% of the scans prior to initiation of this study and 54% since the study were initiated by the neurologist assigned to Darnall Army Community Hospital (See Part II, Discussion for additional information). Apparently many uses for

whole-body CT scans were being overlooked.

Factors Bearing on the Study

One of the first factors bearing on the study was whether to limit the investigation to a head scanner or to investigate the need for a full-body scanner. A decision paper was prepared for the commander and is attached at Appendix A. It was determined that adequate space existed for both types of scanners. In fact, both required approximately the same amount of space, varying from 500 to 850 square feet, depending on the brand of equipment.

The cost for a head scanner versus a whole-body scanner was not the same, however. As indicated in Appendix A, whole-body scanners cost about twice as much as head scanners. Another interesting note is that many manufacturers are no longer making head scanners. The move within the industry clearly is toward whole-body scanners. An editorial in the New Zealand Medical Journal states that "to some extent body scanning with CT is still in search of a destiny, while its place with the head is securely based."[5]

Doctors Ronald Evens and Gilbert Jost state:

> Most CT unit acquisitions in the past two years and most projected acquisitions are BCT (body scanner) units. We believe this trend will continue because of BCT's versatility over HCT (head scanner), the rapidly growing list of diagnostic uses for BCT, and the tendency for most manufacturers to improve the technology of BCT versus HCT units.[6]

The commander's decision was to investigate the needs for a

whole-body scanner.

Literature Review

TECHNOLOGY:

Webster's defines the word scan as "to look at closely; scrutinize."[7] This is essentially what CT scanners do. Each element that makes up an image or cross section of the body is analyzed as to its position, respective to other elements and its relative density. Therefore, to faithfully reproduce an image at least four conditions must be achieved:

1. The image must be split up into as many elements as possible.

2. Each element must be as small as possible or practical.

3. The respective position of each element must be maintained.

4. The correct relationship of the characteristic of each element must also be maintained.[8]

The CT scanner "views" a cross section of the human body from a great number of radiographic projections. These projections are translated into mathematical equations by the computer and the intersection of projections or common points are determined mathematically. To accomplish this the radiographic tube actually rotates around the body in order to provide the different projections.

The basic difference in scanners stems from the different mechanical methods used to accomplish the scan. The earliest

scanners were translate and rotate scanners. One detector and x-ray tube were used. The x-ray tube, rigidly coupled to the detectors, would translate, or linearly move parallel to the subject, while a number of exposures were made. Then the tube and detector would rotate a fixed number of degrees and the translate process would be repeated. Scanning time was between three and six minutes.

The second generation scanner was basically the same, but utilized a number of detectors instead of one. The x-ray tube and detectors were still subject to translation and rotation. The scanning time was reduced to between 20 and 50 seconds.

The next improvement involved two major changes. First, the number of detectors was again increased from approximately 20 to between 200 and 600. Secondly, and because of the first change, the need for translation was eliminated. The detectors, still rigidly coupled to the x-ray tube, formed an arc of a circle around the patient. Scanning time has been reduced to between 2.5 and 10 seconds.[9]

CT scanners are primarily the same as any other radiographic piece of equipment, with some very important differences. Normal x-ray procedures are not capable of detecting small differences in x-ray absorption or, "in other words, in discriminating between tissues of very nearly the same density"[10] ... "CT scanners have a discriminating power approximately five times that of conven-

tional radiographic equipment."[11] This is absolutely critical in detecting or visualizing soft tissue anatomy. Internal organs which are mere shadows on normal x-rays are clearly visable in CT scans.

Another problem with conventional equipment is related to the superposition of information above and below the anatomical area of interest. It is the problem of reducing to two dimensions that which is, in reality, three dimensional. The CT scanner, through the mathematical processes of the computer, focuses clearly on each unit of the cross section of human body, and filters out other areas not in focus. Since each unit is essentially viewed this way separately, and the computer only reproduces the focused units, the total picture displayed is remarkably clear.

ADVANTAGES OF CT SCANNING:

A writer in the South African Medical Journal stated that, "computed tomography is actually less expensive than many other methods, considering its diagnostic potential ...."[12]

CT has other advantages, such as:

> Anatomically and diagnostically the crux of the matter is that CT produces images that are much clearer as anatomical sections and can be recognized as such without too much difficulty, whereas even the best ultrasonic images require explanation and guidance for untrained doctors.[13]

Further literature review revealed the following uses:

> ... the superiority of CT, compared with other neuroradiologic procedures [is] in the early detection and

> diagnosis of intracranial disease.[14]
>
> ... CT has revolutionized neuroradiological diagnosis and in centers where it has become established has displaced conventional techniques such as air encephalography, angiography, and isotope scanning.[15]
>
> The appeal of CT is based on three important traits. The method is uniquely capable of displaying cross sectional anatomy never before accessible in a form readily understood and interpreted. A second important attribute is the capacity to discriminate small differences in tissue density, both visually and quantitatively. A third compelling attraction is that it is non-invasive.[16]
>
> ... [one] could imagine the day when the dialysis machine would join the iron lung in the hospital basement, but ... could not imagine ever again practicing medicine without the CT scanner ....[17]

New and different uses for the whole-body CT scanner are being validated each and every day. The task which lay ahead was to validate as many uses as possible at Darnall Army Community Hospital and develop dependable workload data.

CRITERIA:

CT scanners are highly visible and very controversial items of equipment within the health care industry. Much has been debated about them and there is a great deal of information on what others have determined to be adequate justification.

Albert Rohling, Executive Director, Birmingham Regional Health Systems Agency in Birmingham, Alabama, established 28 criteria for CT scanner acquisition. Highlighting seven of these, he states:

1. We developed a hospital size criterion for whole body scanners -- 300 beds.

2. We developed a hospital size criterion for head-only scanners -- 400 beds.

3. We required a demonstration by the applicant that a minimum of 3850 procedures would be done in the second year.

4. A community-wide requirement stipulates that addition of a CAT scanner would not cause any existing unit to operate at less than 80 percent capacity.

5. A demonstration by the applicant of cost-effectiveness is required in terms of the projected number of diagnostic procedures likely to be replaced by a CAT scanner.

6. There is a requirement that any unit granted a certificate of need will comply with a detailed data generation project supporting both process studies and outcome studies of CAT scanner units.

7. We suggested a set of separate but similar requirements for free-standing CAT scanner units, most of which are immune to certificate of need in Alabama.[18]

An American Hospital Association study included criteria used by other health planners in justifying CT scanners. These included:

Minimum utilization should be 2,080 CT scans annually (8 scans per day, 5 days per week, 52 weeks per year).

CT scans should be used for a minimum of 40 hours per week.

Utilization should be at least 12 patients per shift, with at least 3000 scans annually.

Minimum utilization should be 8 patients per day.[19]

These differing criteria, and they are by no means inclusive

of all criteria established, did nothing to assist health planners at State levels, much less National level. Finally, in 1978, the National Guidelines for Health Planning was published by the Department of Health, Education, and Welfare. In it was stated the following guideline:

> A computed tomographic scanner (head and body) should operate at a minimum of 2,500 medically necessary patient procedures per year, for the second year of its operation and thereafter.[20]

While the Department of HEW admits that estimates of efficient CT scanner utilization vary "from 1800 to over 4000 patient procedures a year,"[21] 2500 procedures has been determined to be a reasonable number. Furthermore:

> In arriving at a standard for the use of these machines, the Department has considered a variety of factors, including the difference in time required for head scans and body scans, the need for multiple scans in some patient examinations, variations in patient mix, the special needs of children, time required for maintenance, and staffing requirements.[22]

The Department of HEW has asked for comments reference these guidelines, but no proposed changes have been issued.[23] The validity of 2500 scans as a standard is controversial. For instance, Ronald Enlow, et. al., in their article protest that:

> The direct effect of these guidelines will be to penalize those geographic areas having slow scanners and whose medical orientation dictates a large number of body procedures. In short, a standard based on yearly procedures counts alone may very well serve to restrict unnecessarily the accessibility of citizens to this diagnostic technique.[24]

Objectives

The objectives of this study are to:

1. Determine a usable criteria for assessing the need for a whole-body CT scanner.

2. Review and document historical workload.

3. Attempt to capture all "medically indicated" cases through use of a physician survey and education program.

4. Compare the results of the survey with the criteria objectively, and make recommendations based upon the conclusions of this comparison.

Criteria

There are several criteria for determining the need for a CT scanner at Darnall Army Community Hospital. First, an adequate patient workload criteria should be established. In the absence of other published criteria, the 2500 procedures per year determined by the Department of Health, Education, and Welfare will be used. It should be noted however that this criteria is not necessarily the best. Hospitals operating in remote areas, where transportation of patients is a problem, may well have justification for a scanner with less than 2500 procedures.

Second, the cost of alternative means of providing this diagnostic service must be compared. Included are transportation costs, costs of lost duty time, inconvenience, inherent danger to

patients because of transportation, and others.

A third criteria is the state-of-the-art in diagnostic medicine. What health conditions must now be confirmed by CT scanner? Can medical residency training be adequately conducted in institutions which lack a scanner?

For the purpose of this paper, only the potential workload for a CT scanner will be completely examined. The state-of-the-art is included in the attempt to educate the physicians, in order to capture all the workload. Examination of the relative costs of alternate methods of providing scanner coverage remains for future study.

Limitations

There are, in fact, few limitations in assessing the needs for a CT scanner. There are several limitations to acquiring a scanner, including: the uncertainty of approval in principle; of obtaining necessary funding; and of obtaining approval for facility changes. The primary limitation in this study, and the one which is later discussed, is the limitation of obtaining full and complete cooperation by the physician staff in determining which patients treated here are legitimate candidates for CT scan.

Assumptions

The only assumptions that need be made, in view of the scope of this paper, are that the supported troop and dependent

population will remain constant and that medical care will continue to be authorized and available for all eligible beneficiaries.

Footnotes

[1]American Hospital Association, CT Scanners: A Technical Report (Chicago: American Hospital Association, [1977]), p.7.

[2]Ibid.

[3]Ibid. p. 16.

[4]Arnold S. Relman, "CAT Scanners," Medical Care Review 36 (December 1979): 1210-11.

[5]"Computed Tomography," New Zealand Medical Journal 88 (9 August 1978): 106.

[6]Ronald G. Evens and Gilbert R. Jost, "Utilization of Body Computed Tomography Units," Radiology 131 (June 1979): 695.

[7]Webster's New World Dictionary, college edition, (1964), s.v. "Scan."

[8]Philips, Medical Systems, Inv., Product Information on the Philips CT Scanner, 1976, p. 2.

[9]Ibid. p. 5-6.

[10]Ibid. p. 3.

[11]Ibid. p. 4.

[12]P. D. deVilliers, "The Economics of Computed Tomography," South African Medical Journal 53 (15 April 1978): 568.

[13]Louis Kreel and Hylton B. Meive, "The Diagnostic Process: A Comparison of Scanning Techniques," British Medical Journal 2 (24 September 1977): 809.

[14]Robert H. Kennedy, Hillier L. Baker, Jr., Wayne O. Houser, Jack P. Whisnant, and Margaret A. Kennedy, "Neurologic Computed Tomography in a Defined Population Group," Radiology 130 (January 1979): 153.

[15]Kreel and Meine, p. 110.

[16]Herbert L. Abrams and Barbara J. McNeil, "Computed Tomography: Cost and Efficacy," American Journal of Roentgenol 131 (July 1978): 81

[17]J. O. Godden, "National Symposium on Diagnostic Imaging Reviews Value and Economics of Imaging Modalities," Canadian Medical Association Journal 120 (20 January 1979): 219.

[18]Albert H. Rohling, "Health Regulation and Technology with a Focus on CAT Scanning," Alabama Journal of the Medical Sciences 15 (July 1978): 305.

[19]American Hospital Association, p. 66.

[20]Department of Health, Education, and Welfare, National Guidelines for Health Planning (Washington, D.C.: Government Printing Office, [1978]), p. 14.

[21]Ibid.

[22]Ibid. p. 15.

[23]Interview with Susan Larson, Central Texas Health Systems Agency, Austin, Texas, February 1980.

[24]Ronald A. Enlow, Karen Ehlert, William Glenn, John Hodak, Kenneth Rall, and William J. Wilson," Utilization of Computed Tomography Scanners and the Health Planning Issue: A Process Data Summary." Journal of Computer Assisted Tomography 3 (April 1979): 260.

2. DISCUSSION

Why A CT Scanner?

There is some evidence to indicate that the technological explosion in medicine involves an element of "keeping up with the Jonese's." In other words, hospitals want the most modern equipment to attract physicians to their hospitals. It is not acceptable to have a piece of equipment available in another institution. In such a situation one institution may have a perceived advantage over another. While the debate over CT scanners includes this element, it is also much broader than this.

As noted in the quotations from the literature review conducted, the uses for CT scanners are expanding, becoming more widely accepted as state-of-the-art diagnostic medicine. Dr. Alfred Bollet has rather accurately portrayed the problem of the CT scanner debate when it is reduced to mere numbers of patients and dollars and cents in the following quotation:

> The health planners have a difficult time understanding the meaning of displacement of old techniques for diagnosis. The fact that pneumoencephalograms are now rarely needed is just a cold fact, as is the increased diagnostic accuracy of the CAT scanner. The pain and misery patients have been spared and the shortened hospital stays do not appear in these tables. We can make these points in conversation, but the problem of making the medical significance clear is illustrated by a conversation I

> had recently about planning for CAT scanners in one region. 'We'll put the scanner at hospital A,' they told me, and patients admitted to hospital B who have a subdural hematoma can be transferred to hospital A, where the neuroradiologist and neurosurgeon will be located for definitive therapy.' 'Fine,' I said. 'That makes a perfect organizational sense. But it means that the physicians in hospital B have made the diagnosis of subdural hematoma without the CAT scanner.' According to such thinking, we either don't need it for such cases at all, or we submit all patients suspected of having a subdural to costly, invasive, traumatic and less accurate procedures, or we transfer every patient with head trauma (a very common problem in this hospital with a very active emergency service) to hospital A for workup.'

This is exactly the case at Darnall Army Community Hospital. With a very active emergency service now; the starting of an emergency medicine residency training program soon; active involvement in training residents in medicine, surgery and obstetrics and gynecology; and a large supported population of every age group, there are many patients who would benefit from the diagnostic capabilities of a whole-body CT scanner. Unless the patient meets a very restricted medical criteria, primarily involved with head injuries or disorders, often the scan is not performed and other, less reliable diagnostic modality is used. The narrowness of this criteria most likely stems from physician unfamiliarity with whole-body CT scanners and their unavailability in the geographical area.

The mixture of physician specialties; complexities of the training and education being conducted; and ever increasing sophistication of the medicine practiced, collectively, but subjectively,

justify a whole-body CT scanner at Darnall Army Community Hospital. However, the current policies directing the application process for a high-cost item such as a CT scanner require that the need must be objectively demonstrated. Whether or not this could be demonstrated was the purpose of this study.

Analysis of Historical Workload Data

It became quickly apparent after beginning to investigate the historical workload data available, that it was incomplete and therefore inaccurate. Workload data maintained in the Comptroller's office revealed that the average number of CT head scans referred to Scott and White Memorial Hospital was three per month in Fiscal Year 1978, and 20 per month in Fiscal Year 1979 (See Appendix B). It was estimated that a similar number was performed each month on patients transferred to Brooke Army Medical Center. This had to be estimated because patients transferred there were not explicitly transferred for the purpose of obtaining a CT scan, and no actual statistics existed. Conversations with several physicians assigned to Darnall Army Community Hospital indicated that probably 20 transferred patients per month would receive a CT scan.

This combined figure of 40 to 50 patients per month who receive CT scans, is obviously significantly less than the monthly average needed to produce the 2500 procedures per year, established as our criterion. But did this number, in fact, capture all potential workload? Were there patients who were legitimate candidates

for a CT scan, but because of some reason, not actually referred for one?

To answer these questions, two things were initially done. First, and as previously discussed, a detailed review of current literature was conducted, to gather some information on what the state-of-the-art was in CT scanning. This review indicated that many procedures were being done by other institutions which were not being done here. In fact, the proven capabilities of body CT scanning, as opposed to merely head scanning, seemed to be sorely overlooked.

Secondly, an informal, verbal survey was made of many physicians assigned to the hospital. This revealed a significant unawareness on their part of what whole-body CT scanning was currently capable of doing. Much of this stems from the fact that many physicians had never been afforded the opportunity to actually work with a scanner. Also, few envisioned having that opportunity while assigned to Darnall Army Community Hospital. However, there was a great deal of evidence that physicians were indeed seeing patients who were medically legitimate CT scan patients.

Physician Survey

The results of the informal survey were discussed with the Hospital Commander and the Chief of Professional Services. Based on this conversation, it was decided to conduct a three-month formal survey, to determine if any of the suspected, undocumented needs

for a CT scanner could be captured. A copy of this survey, with instructions from Colonel William W. Burgin, MC, Chief of Professional Services, is attached at Appendix C. The purpose and procedures of this survey were discussed at the monthly clinical meetings and the chiefs' meetings.

Despite the best of intentions, there were problems with the survey. Some physicians thought it was to be used to actually order CT scans. Since it was not intended as such, and, in fact, created some duplication in work, some ill feelings were experienced. Although the goal was to survey the months of February, March and April, this too was not clearly presented. Although most services did survey the desired months, one service did not -- surveying instead January, February and March.

There was no daily screening of survey reports. This is necessary for several reasons. First, quality control must be maintained by having the forms screened by a knowledgeable physician, perhaps the Chief of Radiology, to insure that all scans were medically indicated. Secondly, they need to be administratively screened to insure completeness of data. Many surveys, for instance, did not indicate whether a scan was ordered or would have been ordered. Since some clinics kept all their surveys until the completion of the study, it was clerically impossible to go back and obtain this information.

There was insufficient lead time to thoroughly prepare for

the survey and properly introduce it to the physician staff. This created confusion, which most assuredly led to some data being initially lost. As stated above, there was also avoidable confusion on the part of many participating physicians. In fact, the results of the survey indicate that some physicians were never clearly read into the survey.

Physician Education Program

It has been previously stated that many physicians were not truly aware of the diagnostic possibilities of whole-body CT scanners. The fact that they had never worked with one; had no expectations of working with one at Darnall Army Community Hospital, or any number of other reasons, combined to mellow their interest in CT scanning to the point that it was most probably overlooked as a primary or adjunct diagnostic tool.

Because of this it was decided, with the approval of the Hospital Commander and Chief of Professional Services, to begin an educational program for the physicians. The initial action was to distribute to all physicians a copy of a special report which appeared in the July 1979 issue of the American Journal of Roentgenology (Appendix D). The purpose of this was to stimulate the physicians -- to get them thinking of how CT scanning could be applied to their specialty area.

More important than this, however, was the decision to offer a class to all physicians on CT scanning. This was made part

of the continuing health education program and continuing medical education credit was given to all who attended. At Appendix E is a copy of the course's plan, with its objectives and agenda. The class was sponsored by General Electric Corporation, and the primary lecturer was Dr. Alan Williams, Assistant Professor of Radiology at the Medical College of Wisconsin.

In order to allow maximum attendance by physicians and other health practitioners, it was given in the evening of 25 March, at the Fort Hood Officers' Open Mess. Those who desired to attend were encouraged to meet for dinner, and then stay for the two-hour lecture. Approximately 60 people attended the class, which was exceptionally well received.

The results of the education program, coupled with the survey, seem to have been excellent. The number of patients referred per month through the Comptroller Division for CT scan increased from an average of 23 scans per month in the first quarter of Fiscal Year 80, to 76 scans during March 1980. Undoubtedly the education program, with increased emphasis on CT scanning, improved the likelihood of documenting all medically indicated procedures during the survey period.[3]

Analysis of the Survey

The statistical results of the survey are presented in Appendices F and G. The month with the most cases is March, with 94 medically indicated CT scanner cases. This included both scans ordered

and those that would have been ordered if a scanner were available here. As mentioned, only General Surgery Service conducted the survey in January, and did not conduct it in April. Approximately 25% of the scans would have been, or were, performed on inpatients. More significant is the fact that over 94% of the cases reported in the survey were for head scans. Furthermore, as indicated in Appendix G, most were requested by Neurology Service.

This is significantly below the workload differentiation experienced in other studies. Dr. Raymond W. Brust, Jr., reporting on the first six months' experience with the initial whole-body CT scanner in Hawaii, stated that "head scans accounted for 60%, while 40% were body scans."[4] Doctors Ronald G. Evens and R. Gilbert Jost surveyed 64 whole-body CT scanner uses and discovered that 55% of all examinations were head scans and 45% were body scans.[5] In another study, conducted by Ronald Enlow, et. al., of three hospital CT scanner units, body scan constituted 17% of the total scans in one, and 32% in the other (one hospital only had a head CT scanner).[6]

There is every indication, therefore, that many body scans were not documented on the survey. Additionally, there were services which did not report any scans. For instance, there were no survey forms completed for emergency CT scans. Conversation with Captain Byron Vaughn, Chief of Operational and Emergency Medicine, revealed that he estimated there would be approximately 30 emergency

medicine requests for CT scan per month, if one were available.

Orthopedic Service also did not document any CT scan cases. Major Dewey MacKay, Chief of the Orthopedic Service, indicated that they would request between three to five scans per month.[8] If one were to extract what others are doing with CT scanners, additional cases might be considered medically necessary. For instance, the University of Colorado Health Sciences Center News states that "all babies weighing less than 1500 grams (3.3 pounds) should have a CT scan during their first week of life."[9] Darnall Army Community Hospital has one to two such births a month. Captain Glenn E. Sparks, Jr., Chief of the Newborn Nursery, also points out that an additional two to three babies a month would need CT scans for clinical indications.[10]

The administrative problems connected with the survey have been previously discussed. Those problems certainly contributed to some medically indicated CT procedures remaining undocumented. The cooperation and support of the physician staff is paramount to the success of such a survey. There is no indication that this was absent from this survey.

Comparison of Survey Results with Criteria

Despite the fact that Doctors Evens and Jost reported in their study that "only 17% of institutions meet the National Guidelines of 2500 patient examinations per year,"[11] that guideline was established as the criterion for this paper. That equates to

approximately 208 procedures per month. The average monthly procedures documented by the survey were about 78. If you add the 30 to 40 procedures per month undocumented, but evidenced in conversations, the average approaches 110 to 120 medically indicated procedures per month. This is still significantly below the guidelines.

Footnotes

[1]Alfred Jay Bollet, "The CAT Scan Debate," Resident and Staff Physician 25 (April 1979): p. 42.

[2]Hayward, William, Budget Analyst, US Darnall Army Community Hospital, Fort Hood, Texas, Interview April 1980.

[3]Ibid. Interview May 1980.

[4]Brust, Raymond W., Jr., "Initial Experience with the First Whole-Body Computerized Tomography Scanner in Hawaii," Hawaii Medical Journal 38 (May 1979): 132.

[5]Evens, Ronald G. and Jost, R. Gilbert, "Utilization of Body Computed Tomography Units," Radiology 131 (June 1979): 695.

[6]Enlow, Ronald A.; Ehlert, Karen; Glenn, William; Hodak, John; Rall, Kenneth; and Wilson, William J. "Utilization of Computed Tomography Scanners and the Health Planning Issue: A Process Data Summary," Journal of Computer Assisted Tomography 3 (April 1979): 258.

[7]Vaughn, Prentis B., Chief of Operational and Emergency Medicine, US Darnall Army Community Hospital, Fort Hood, Texas, Interview May 1980.

[8]MacKay, Dewey C. III, Chief, Orthopedic Service, US Darnall Army Community Hospital, Fort Hood, Texas, Interview May 1980.

[9]"CT Scans Recommended on All Newborns Under 1500 Grams." University of Colorado Health Science Center News February 1980: 3

[10]Sparks, Glenn E., Jr., Chief of the Newborn Nursery, US Darnall Army Community Hospital, Fort Hood, Texas, Interview April 1980.

[11]Evens and Jost, p. 695.

3. CONCLUSION AND RECOMMENDATIONS

Conclusion

US Darnall Army Community Hospital has not been able to document sufficient, medically-indicated, cases for a whole-body CT scanner to justify further development of an application for the equipment. Although there is evidence that all cases were not reported, even a reasonably defendable number of cases is significantly less than the criteria.

As mentioned in the discussion, the number of cases reported for body scans is very low. The exact reason for this cannot be determined by the survey, but indications are that many uses for body CT scanning are not part of the physicians' normally used diagnostic tools.

Recommendations

It is not recommended that an application for a whole-body CT scanner be made at this time. It is recommended, however, that another survey be conducted later this year or early next year. Steps should be taken to preclude the administrative problems discussed in the paper, and a thorough physician education program should be initiated prior to the start of the survey. The criteria

should remain the same unless the Department of Health, Education and Welfare changes it, or other criteria is submitted for federal institutions.

Recommendation for Future Study

There are two areas which merit additional study. The first is the adequacy of the workload criteria established by the Department of Health, Education, and Welfare. The question to be answered is whether this criteria is realistic for Army hospitals, especially those in isolated locations where transportation of patients is a problem.

In conjunction with this is the second study, which should be a cost-benefit analysis of alternative methods of providing CT scanner coverage. The additional costs related to transporting patients and the increased risk of transporting critically ill patients relatively long distances may demonstrate that an in-house CT scanner capability is more cost effective, even if 2500 procedures are not performed.

APPENDICES

APPENDIX A

Decision paper to Determine Whether Darnall Army Community Hospital Would Pursue Obtaining A Head or Whole-Body CT Scanner

DISPOSITION FORM

For use of this form, see AR 340-15, the proponent agency is TAGCEN.

REFERENCE OR OFFICE SYMBOL	SUBJECT
AFZF-H	CT Scanner

XXX THRU XO, USDAH

TO Cdr, USDAH

FROM CPT Kerrigan, Admin Resident

DATE 30 Jan 80

CMT 1 mdw/2402

1. THIS IS A DECISION PAPER.

2. PURPOSE. To determine whether USDAH should pursue obtaining a head or full-body CT scanner.

3. DISCUSSION.

a. Adequate space for either type of CT scanner will be available upon completion of the renovation and expansion project. Estimates for required space range from 500-850 sq ft (see TAB A for alternative locations).

b. Workload and cost figures for use of the CT scanner at Scott and White are at TAB B. Although the figures from BAMC are not yet available, it is not envisioned that they will significantly increase the average of 23 per month.

c. Relative cost figures for procuring a scanner are at TAB C.

d. Currently, most scans requested by USDAH are head scans. There is, however, sufficient literature to demonstrate that CT scanners (and especially whole-body scanners) are a state-of-the-art diagnostic tool for hospitals of USDAH's size. TAB D presents extracted quotations from a 1977 American Hospital Association report on CT scanners. The historical workload figures are probably not enough to justify a CT scanner.

4. RECOMMENDATION.

a. That location alternative 3 be selected as the future CT scanner site.

b. That acquirement of a CT scanner be pursued primarily on the basis of state-of-the-art medicine, with emphasis on our Emergency Medicine Residency Program, other residency affiliations, and increasing sophistication of the medical capabilities of USDAH.

c. That a whole-body CT scanner be our goal because of its versatility, dominance in the field of new CT technology, and we owe it to ourselves to try for the best.

4 Incl
as

JOHN R. KERRIGAN
CPT, MSC
Administrative Resident

☆ U.S.GPO:1977-0-765-124/152

ALTERNATIVE 1

AREAS: Equipment & Supply Room
Janitor Closet
Lounge

TOTAL SQUARE FOOTAGE: 513 sq ft

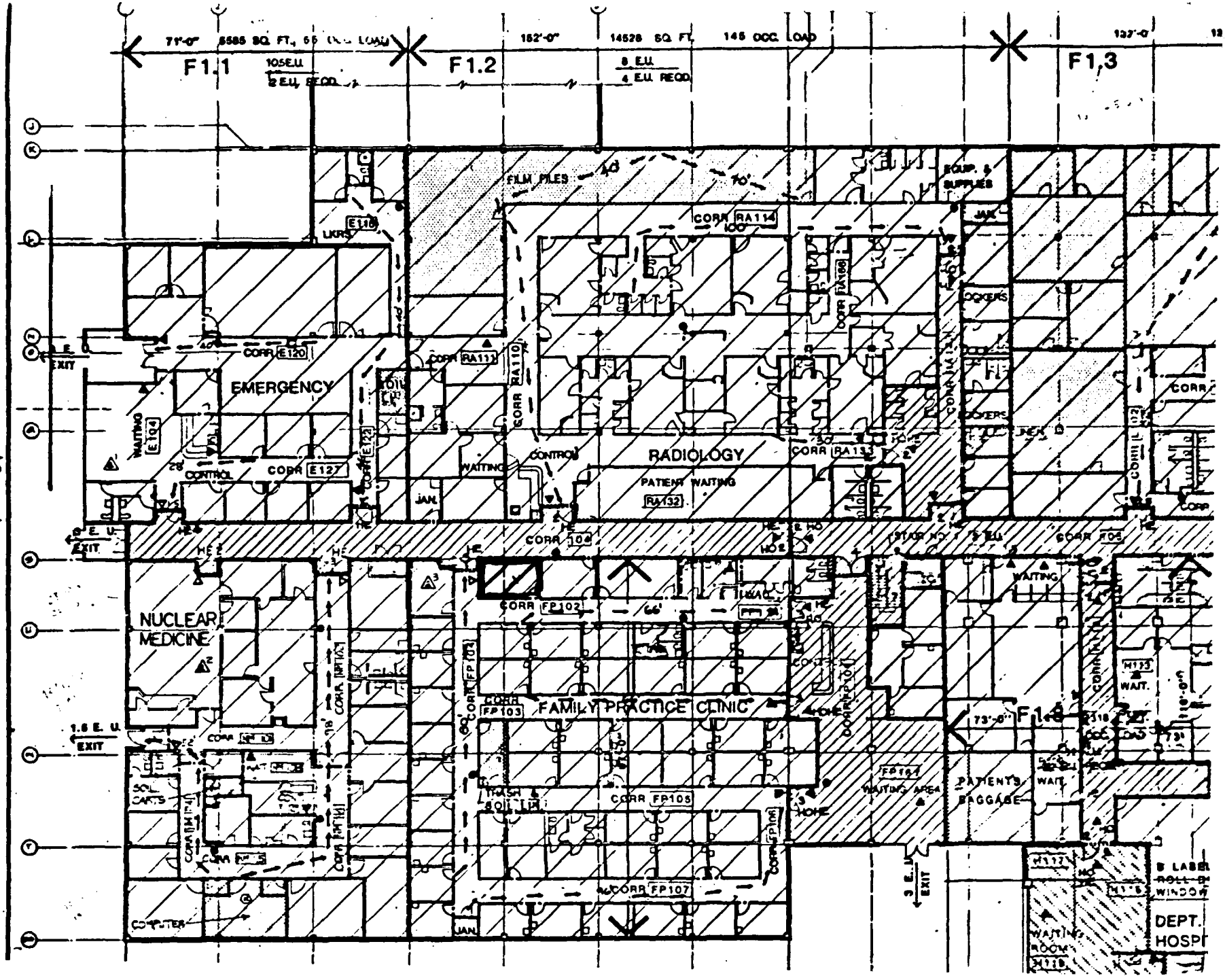
ADVANTAGES:

1. It is witnin the Department of Radiology and therefore supervision, patient waiting area, patient flow and departmental integrity is maintained.

DISADVANTAGES:

1. Department of Radiology looses lounge area for personnel. However, there is a lounge area across the corridor in Family Practice Clinic (indicated by red markings).

2. Square footage may not meet requirements of all brands of equipment and may limit future expansion.


F1.1
F1.2
F1,3
EMERGENCY
RADIOLOGY
PATIENT WAITING
RA132
NUCLEAR MEDICINE
FAMILY PRACTICE CLINIC
FILM FILES
EQUIP. & SUPPLIES
CORR RA114
CORR E120
CORR E127
CORR RA111
CORR RA110
CORR RA113
CORR RA135
CORR 102
CORR FP102
CORR FP103
CORR FP105
CORR FP107
WAITING
CONTROL
JAN.
COMPUTER
SOIL CARTS
TRASH & SOILED
PATIENT'S BAGGAGE
WAIT.
WAITING ROOM
DEPT. HOSP
1.6 E. U. EXIT
3 E. U. EXIT
E. U. EXIT
105 E.U.
2 E.U. REQD.
8 E.U.
4 E.U. REQD.
14528 SQ. FT.
145 OCC. LOAD
73'-0"
34

ALTERNATIVE 2

AREAS: Equipment & Supply Room
Ultrasound Dressing Room

TOTAL SQUARE FOOTAGE: 521 sq ft

ADVANTAGES:

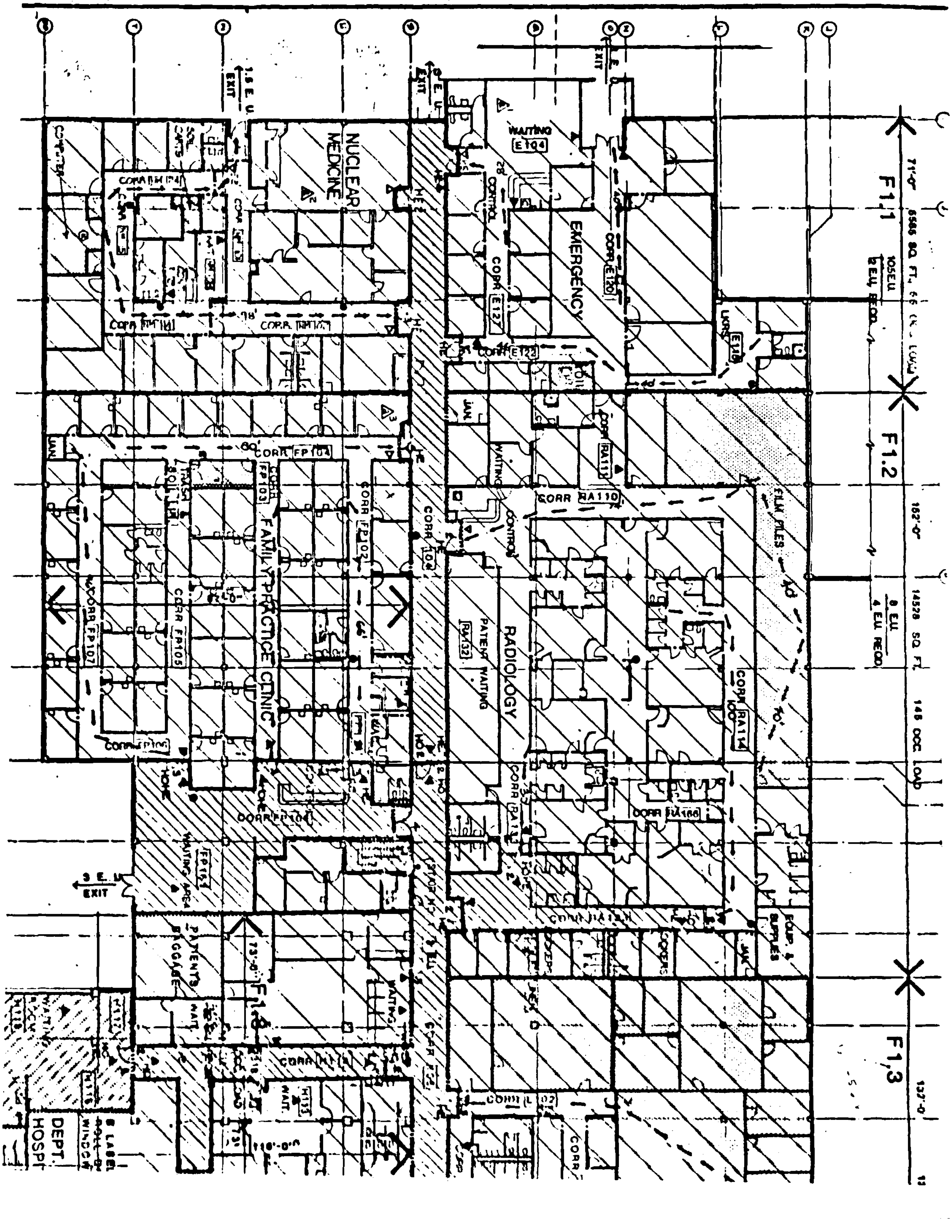
1. It is within the Department of Radiology and therefore supervision, patient waiting area, patient flow and departmental integrity is maintained.

2. Department personnel have a lounge.

DISADVANTAGES:

1. A large dressing area is loss to patient use. There are however, other dressing areas within the clinic.

2. Square footage may not meet the requirements of all brands of equipment, and may limit future expansion.


F1.1
F1.2
F1,3
F1.4
NUCLEAR MEDICINE
EMERGENCY
RADIOLOGY
FAMILY PRACTICE CLINIC
WAITING
E104
PATIENT WAITING
FILM FILES
PATIENTS BAGGAGE
DEPT. HOSPT.

ALTERNATIVE 3

AREAS: Plans, Operations & Training

TOTAL SQUARE FOOTAGE: 1052 sq ft

ADVANTAGES:

1. Square footage will most likely meet the requirements of all brands of equipment, and future expansion.

2. Does not alter the plans for the Department of Radiology and the functional provisions contained within them.

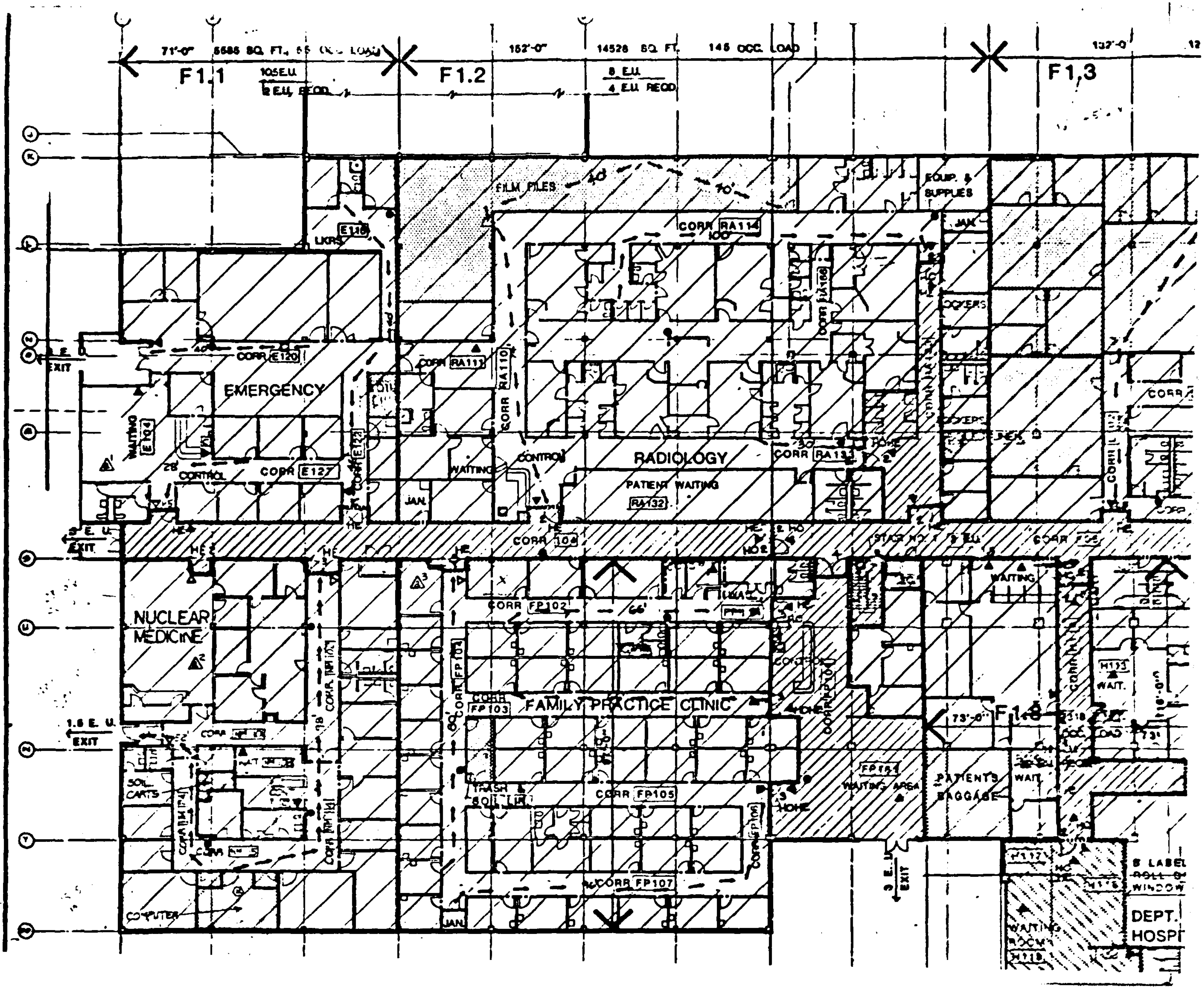
3. Does not interfere with provisions for clinical staff or patients.

4. It is located across the corridor from Nuclear Medicine and can use that waiting area.

DISADVANTAGES:

1. It is not within the Department of Radiology, although it is across a corridor from Nuclear Medicine. Supervision, patient flow, etc. will be a little more difficult.

2. Plans, Operations and Training must be relocated to another location, most probably outside the hospital.


F1.1
F1.2
F1,3
71'-0"
5585 SQ. FT.
152'-0"
14528 SQ. FT.
145 OCC. LOAD
132'-0"
8 E.U.
4 E.U. REQD
FILM FILES
EQUIP. & SUPPLIES
JAN.
CORR RA114
EMERGENCY
CORR E120
CORR E127
CONTROL
WAITING E104
CORR RA110
CORR RA113
RADIOLOGY
PATIENT WAITING
RA132
CONTROL
WAITING
CORR 104
NUCLEAR MEDICINE
FAMILY PRACTICE CLINIC
CORR FP102
CORR FP103
CORR FP105
CORR FP107
TRASH & SOIL LIN.
WAITING AREA
PATIENTS BAGGAGE
WAIT.
WAITING ROOM
SOIL CARTS
COMPUTER
EXIT
1.5 E. U.
3 E. U.
DEPT.
HOSP

CT BRAIN SCANS REFERRAL TO SCOTT & WHITE

PERIOD	SCANS/MONTH	TOTAL COST FOR PERIOD
FY 78	3	$ 7,440
FY 79	20	$51,675
FY 80 thru Dec	23	$14,850
		PROJECTED: $59,400

NOTE: This does not include transportation costs or costs of loss duty time by attendants

RELATIVE COST COMPARISONS

MANUFACTURER	WHOLE-BODY	HEAD
Siemens	$760,000	$430,000
General Electric	$620,000	Not Made
Picker	$880,000	Not Made
Philips	$850,000	Not Made

EXTRACTS FROM CT SCANNERS: A TECHNICAL REPORT

American Hospital Association, 1977

JUSTIFICATIONS:

"... radiologists and manufacturers' representatives predict that CT scanners will be located in almost all hospitals with 200 or more beds in the near future as clinical applications for whole-body scanners are validated (p 10)

"The majority of new CT orders are for the whole-body unit. Many hospitals with CT head units already approved by the planning agencies have submitted new applications for the full-body unit in lieu of the head unit

"The number of patients scanned per day can be expected to increase as a result of growing professional experience in using the technique and of improvements in equipment. (p 16)

"One important distinction between scanners and earlier technological breakthroughs is that scanners are primarily diagnostic tools rather than therapeutic ones. Thus scanners do not have a narrowly defined, easily identifiable patient population, such as cobalt units have. Rather, the use of scanners is aimed at a broad spectrum of patient groups. (p53)

"Radiologists generally recommend the purchase of full-body scanners because of their additional potential use. (p 53)

"CT services should be coordinated with emergency medical systems. (p 67)

"Research capability should be available to the neurological and/or neurosurgical and related staff with respect to intern and residency programs." (p 67)

USES:

"CT already is the medically accepted procedure for diagnosing many brain abnormalities, such as tumors or strokes. (p 3)

"With CT it may be possible to position biopsy needles more accurately than currently available methods permit. (p 15)

"Periodic CT scans of some patients are being ordered to monitor the response of tumors to chemotherapy or radiation therapy. (p 15)

"Determination of the extent of malignant disease. The CT scan is without peer in determining how far malignant disease has extended in order to plan for treatment. (p 85)

"Solving problems where there is conflicting information, either from several radiologic studies or between radiologic studies and the clinical status of the patient. (p 85)

"Guidance of percutaneous biopsies of deep-seated abdominal and chest masses. (p 86)

"Specific application to organs and regions of the body, such as diagnosis of and determination of extent of mediastinal masses; determination of extent of malignant pulmonary masses; identification of liver masses (metastatic, primary, and inflammatory); diagnosis of benign and malignant disease of the pancreas; additional evaluation of renal masses that have been detected by other modalities; identification and determination of extent of retroperitoneal disease; identification and localization of intra-abdominal abscesses; and identification of and determination of extent of masses in the anatomical pelvis. (p 86)

"The staging of pneumoconiosis and asbestosis cannot be done accurately without a CT scanner. (p 87)

"The staging of malignancies of the chest and abdomen cannot be done without CT scanning. (p 88)

"Studies using CT for heart conditions are under way. (p 88)

"Completed tomography and ultrasound will play complementary roles in abdominal structure imaging. (p 88)

"If ultra short scan times (less than 50 msec) become available, cardiovascular diagnosis could be accomplished. (p 88) (This capability is in the new 4th generation CT scanners.)

"The major advantage of the CT mammography concept is the relatively low radiation dose, that is, between 150 and 300 milliroentgens per breast per examination." (89)

APPENDIX B

Historical Workload Data for CT Scans
(Referrals for FY 78, FY 79, 1st Qtr FY 80)

Historical Workload Data for CT Scanns

(Referrals for FY 78, FY 79, 1st Qtr FY 80)

FY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total	Avg
78	0	1	1	0	0	1	0	1	7	8	3	14	36	3
79	5	14	22	15	24	26	14	18	27	26	33	18	242	20
80	29	24	17											23

Source: Comptroller Division, US Darnall Army Community Hospital

APPENDIX C

Letter from Chief of Professional Services
Outlining Physician Survey, with Survey Attached

DISPOSITION FORM

For use of this form, see AR 340-15; the proponent agency is The Adjutant General's Office.

REFERENCE OR OFFICE SYMBOL	SUBJECT
AFZF-DMA-PSO	CT Scanner

TO All Physicians

FROM Chief, Professional Serv

DATE 5 February 1980

CPT Kerrigan/jkt/7510

1. Darnall Army Community Hospital is in the process of gathering data to justify the acquisition of a whole-body scanner.

2. The actual number of referrals documented in the past is probably not sufficient to justify a scanner without additional information.

3. In order to capture all possible workload figures for a whole-body CT scanner, it is requested that one of the attached DFs be completed on each case actually referred for CT scan, or any case that would have been scanned if one was available. These include patients that cannot be safely moved, as well as patients with diagnoses that professional literature and studies indicate should be CT scanned.

4. Any questions should be directed to CPT John Kerrigan, 5-5311/7510.

William W Burgin

WILLIAM W. BURGIN, JR., M.D.
Colonel, Medical Corps
Chief, Professional Services

DISPOSITION FORM

For use of this form, see AR 340-15; the proponent agency is The Adjutant General's Office.

REFERENCE OR OFFICE SYMBOL	SUBJECT
	CT Scanner

TO	FROM	DATE
Administrative Resident		

1. PATIENT's NAME:_____

2. PATIENT's SOCIAL SECURITY NUMBER:_____

3. DIAGNOSIS:

4. INPATIENT/OUTPATIENT

5. SCAN ORDERED/WOULD HAVE BEEN ORDERED

6. TYPE OF SCAN (Head, Chest, Abdominal, etc.)

_____
Physician's Name

APPENDIX D

Special Report: New Indications for Computed Body Tomography
(Submitted to Medical Staff)

Special Report

New Indications for Computed Body Tomography

Society for Computed Body Tomography

The Society for Computed Body Tomography has prepared the following list of indications for computed tomography in extracranial applications. These new guidelines are intended to clarify, update, and augment the indications published in the April 1977 policy statement of the Institute of Medicine. They reflect the consensus opinion of members of the Society and include many new uses for which CT body scanning has been judged to be clinically indicated by the Society.

The Society met on three separate occasions as a group to formulate, debate, and, by general concensus, to select the following indications. During the Society's first annual meeting in the spring of 1978, members were divided into various subcommittees, each with a chairman and several subcommittee members to examine indications for computed tomography related to a particular organ system. During the ensuing months the chairman of each subcommittee, after discussion with members of the subcommittee, was able to compile a list of indications related to that organ system. Once completed, these were submitted to the president of the Society. They were reorganized, edited, and sent to all members of the Society for their comment and study.

At the scientific meeting of the Society in August 1978, the drafts of the subcommittees were presented to the Society members, where again indications were discussed and selections made by concensus. Between August 1978 and February 1979 additional details were added, and again recirculated to the members. They were again discussed at the annual meeting of the Society, February 1979. Final decisions were made and the document submitted for publication.

Prior to submission for publication, the American College of Radiology, the President of the National Blue Cross, the Secretary of the Department of Health, Education and Welfare, the Office of Technologic Assessment, the Bureau of Radiologic Health, and the Institute of Medicine were contacted and supplied with drafts for their suggestions and comment. In all, the manuscript has gone through six drafts, including preliminary study by the editorial staff of the *American Journal of Roentgenology*.

AJR 133:115–119, July 1979

0361-803X/79/1331-0115 $00.00

Indications for Body CT

Neck

- Determination of the extent of primary and secondary neoplasms of the neck.
- Evaluation of bony abnormalities of the cervical spine including neoplasms, fractures, dislocations, and congenital anomalies.
- Localization of foreign bodies in the soft tissues, hypopharynx, or larynx and assessment of airway integrity after trauma.
- Evaluation of retropharyngeal abscesses.

Mediastinum

- Evaluation of problems presented by chest radiograph.
  - —— Mass.
    - — Differentiation among cystic, fatty, or solid nature.
    - — Localization relative to other mediastinal structures.
  - —— Mediastinal widening.
    - — Assessment of whether cause is pathologic or anatomic variation.
    - — Distinction of solid mass, vascular anomaly, or aneurysm, and physiologic fat deposition.
  - —— Hilum.
    - — Differentiation of enlarged pulmonary artery from solid mass when conventional tomography fails or is not capable of making this distinction.
  - —— Paraspinal line widening.
    - — Distinction among lymph node enlargement, vascular cause, or anatomic variant.
- Search for occult thymic lesion.
  - —— Detection of thymoma or hyperplasia in selected patients with myasthenia gravis when plain chest radiography is negative or suspicious.

Lung

- Search for pulmonary lesions.
  - —— Detection of occult pulmonary metastases when:
    - — Extensive surgery is planned for a known primary neoplasm with a high propensity for lung metastases or for apparent solitary lung metastasis.
  - —— Detection of primary tumor in patient with positive sputum cytology and negative chest radiography and fiberoptic bronchoscopy.
  - —— Assessment of lung and mediastinum for underlying pleural effusion and the postpneumonectomy fibrothorax for recurrent disease.
- Search for diffuse or central calcification in a pulmonary nodule when conventional tomography is indeterminate.
- Determination of extent of intrathoracic spread in selected patients with bronchogenic carcinoma including mediastinal or pleural invasion.

Chest Wall

- Determination of extent of neoplastic disease.
  - —— Assess bone, muscle, and subcutaneous tissues.
  - —— Detection of intrusion into thoracic cavity or spinal canal.

Percutaneous Needle Biopsy

- Assist biopsy of lesions when fluoroscopic guidance inadequate.
  - —— Certain mediastinal masses.
  - —— Mass low in costovertebral angle or obscured by overlying bone.

Heart

- Examinations of intracardiac anatomy are not indicated at this time. Future advances in CT equipment may allow more clinically useful demonstration of cardiac anatomy and physiology.
- Distinction of cardiac (e.g., ventricular aneurysm) from pericardiac (e.g., mediastinal or pulmonary lesion) mass.
- Detection of aortacoronary vein graft occlusion is possible with intravenous contrast medium bolus with third- and fourth-generation scanners.

Major Blood Vessels

- Evaluation and detection of thoracic aortic aneurysms.
- Screening and measurement of abdominal aortic aneurysms when ultrasound fails or is unavailable.
- Detection of intraluminal clots, chronic leakage, and rupture of thoracic and abdominal aneurysms.
- Evaluation of aortoprosthetic disruption.
- Evaluation of suspected infection of synthetic grafts of the major vessels.
- Delineation of relation of major vessels to retroperitoneal tumors, infections, or other abnormalities.
- Demonstration of invasion of vena cava by tumor.

Spine

- Type I examination: No contrast medium. Type II examination: Dilute metrizamide. Type III examination: Concentrated metrizamide instilled originally for conventional myelography with subsequent CT, performed within 4 hours after metrizamide instillation.

- Evaluation (type I) of spinal stenosis to determine extent and specific causes of bony and soft tissue encroachment.
  - —— Diffuse spinal stenosis, congenital or acquired.
  - —— Localized spinal stenosis, associated with degenerative disease or malalignment.
  - —— Posttraumatic stenosis: detection of fracture fragments or hematoma.
  - —— Postspinal fusion stenosis: fusion bone overgrowth.
  - —— Detection of midline or foramenal spurs not seen on plain films.
  - —— Combined causes including degenerative, iatrogenic, traumatic, infection/tumor, as well as herniations of the nucleus pulposus.
- Evaluation (types I and II) of congenital dysraphic abnormalities (spina bifida, meningomyelocele, meningocele, diastematomyelia).
- Evaluation (type I or II) of spinal cord and/or nerve root masses, usually as secondary procedure to further determine nature and extent of lesion.
- Localization procedure (type I) for CT-guided biopsy or aspiration.
- Evaluation (type I) of nature and extent of boney or paraspinal tumors and inflammatory masses.
- Following nondiagnostic conventional myelography (type I or II procedure) using myelogram and/or clinical findings to specify CT level(s).
- Alternative procedure (type I) in situations precluding standard myelography as primary examination (allergic history, mechanical difficulties, emotional factors).

Retroperitoneum

- Detection of primary malignancies such as those of mesenchymal, neural, lymphatic, and embryonic rest origin, melanomas, and benign conditions, such as cysts that may mimic malignancies.
- Staging of nodal and extranodal extension of lymphomas and other types of retroperitoneal metastases from various primary sites (e.g., initial staging or detection of recurrent metastatic testicular tumor).
- Detection of retroperitoneal abscess or hemorrhage (hematoma); localization for needle aspiration.
- Further evaluation when other radiologic studies unexpectedly suggest abnormality, such as deviated ureter by normal retroperitoneal fat.
- Guidance for retroperitoneal biopsy.

Peritoneum

- Detection and differential diagnosis of free or loculated intraperitoneal fluid collections and inflammatory processes.
- Detection of primary or secondary peritoneal masses (neoplasms and abscesses, etc.)
- Guidance for the aspiration of intraperitoneal fluid collections and peritoneal masses.

Liver

- Evaluation of space-occupying lesions.
  - —— *Primary and secondary malignant neoplasms and* clinically significant benign lesions, such as adenomas, cavernous hemangiomas, and abscesses.
    - — *Initial detection; whether liver is primary organ* of interest or examined as part of CT evaluation of other suspected abdominal disease, such as *pancreatic carcinoma, in which knowledge of* associated hepatic lesions is of clinical importance.
    - — *Confirmation of the presence or clarification of* the nature of hepatic lesion(s) suspected or found on other imaging procedure, such as an *inconclusive or nonspecific radionuclide scan.*
    - — Differentiation of solid, cystic, inflammatory, and vascular lesions.
    - — Assessment of location, extent, and number of lesions, when such information is of clinical importance.
    - — Guidance for hepatic biopsy and aspiration.
    - — Assessment of response to nonoperative therapy.
- Evaluation of trauma.
  - —— Detection of hepatic laceration and intrahepatic and subcapsular hematoma, and determination of extent of injury in cases of blunt or penetrating trauma.
- Evaluation of diffuse liver disease.
  - —— CT currently of limited value, but may be useful in specific circumstances, such as detection of fatty infiltration of the liver and conditions of excessive iron deposition (hemochromatosis) and glycogen storage disease in children.

Spleen

- Detection and estimation of age of subcapsular hematoma.
- Detection of intrasplenic mass and differentiation of solid, cystic, and inflammatory lesions.

Pancreas

- Evaluation for possible mass lesion.
  - —— Detection of primary tumor and its extent.
  - —— Search for primary lesion in patient with distant metastases.
  - —— Evaluation of jaundiced patient.
  - —— Evaluation of suspected pancreatitis.
  - —— Evaluation of patient with possible upper abdominal masses.
  - —— Serial assessment of regression or persistence of tumor during and after therapy.
- Differentiation of pancreatic from parapancreatic mass.
  - —— Distinction among solid, cystic, vascular, inflammatory, calcified, and fatty lesions.
- Detection of complications of acute or subacute pancreatitis.

- —— Detection of pseudocysts, their number, size, and extent.
- —— Serial assessment of pseudocyst following medical or surgical management.
- —— Detection of abscess: determination of size and extent.

- Guidance of percutaneous pancreatic biopsy and aspiration procedures.

Kidneys

- Evaluation of kidneys when excretory urography or angiography is contraindicated by risk of serious reaction to contrast medium.
- Evaluation of renal mass or suspected mass detected on another imaging procedure.
  - —— Differentiation of an anatomic variant from a pathologic process.
  - —— Differentiation of a benign fluid-filled cyst from a cyst and/or solid renal mass.
  - —— Determination of the extent of renal neoplasm before and after treatment.
- Evaluation of selected patients, suspected clinically of renal neoplasm, when excretory urogram is negative.
- Evaluation of juxtarenal (para- or perirenal) lesions seen or suspected on excretory urography.
  - —— Differentiation of anatomic variant from pathologic process.
  - —— Determination of the cause, location, and extent of a lesion.
- Evaluation of urographic nonfunctioning kidney(s).
  - —— Assessment of size, outline, and parenchymal thickness.
  - —— Detection of obstruction, determination of site, cause, and extent of disease process.
  - —— Documentation of congenital absence.
  - —— Detection of minimally calcified renal calculi not demonstrated by conventional techniques.
- Determination of cause of renal and perirenal calcification.
- Assessment of extent of renal trauma.
- Guidance for antegrade nephrostomy, renal biopsy, or mass aspiration.

Gallbladder

- CT is not indicated at this time unless oral and intravenous cholecystography and ultrasonography are indeterminate or unobtainable.

Biliary Tree

- Differentiation of obstructive from nonobstructive jaundice.
- Determination of site and etiology of obstruction.
- Determination of etiology of obstruction.

Gastrointestinal Tract

- CT is useful in the assessment of extent or recurrence of tumor or tumorlike condition into the mesentery or adjacent organs. CT is not currently indicated for the detection of mucosal lesions.

Adrenal Gland

- Evaluation of patients with biochemical evidence of adrenal hyperfunction.
- Evaluation of patients with suspicion of adrenal mass found on conventional radiographic examination.
- Guidance for adrenal biopsy.

Uterus and Ovaries

- Evaluation of mass detected by clinical examination, after positive biopsy, after failure of ultrasound examination, or when strong clinical suspicion exists for a mass lesion.
- Evaluation of primary tumor and its extent of spread; and evaluation of secondary tumor.
- Differentiation of solid, cystic, inflammatory, vascular, or fatty masses.
- Guidance for uterine and ovarian biopsy.

Bladder, Ureters, Prostate, and Seminal Vesicles

- Evaluation of primary and secondary tumor, including extent of tumor.
- Differentiation of solid, cystic, inflammatory, vascular, or fatty tumors.
- Detection of obstructing, minimally calcified ureteral calculi not detected by conventional studies.
- Guidance for biopsy.

Pelvic Bones

- Evaluation of bone lesions and accompanying soft tissue extent.
- Guidance for biopsy.

Musculoskeletal System

- Evaluation of selected patients with known or suspected primary bone tumors.
- Evaluation of patients with suspected recurrence of bone tumors.
- Evaluation of patients with suspected but indefinite signs of skeletal metastases when conventional studies fail to clarify.
- Evaluation of joint abnormalities difficult to detect by conventional methods.
- Evaluation of patients with soft tissue tumors, either

known or suspected to confirm presence and determine extent.
- Guidance for biopsy.

Therapy Planning and Followup

- Definition of cross-sectional anatomy and attenuation coefficients of bone and soft tissue in tumor-bearing areas for the purpose of planning radiation therapy.
- Provision of baseline prior to radiation therapy and chemotherapy from which effectiveness of these treatment modalities can be judged.
- Conformance as part of an established and acceptable follow-up protocol.
- Evaluation of signs and symptoms suggesting progression, recurrence, or failure of therapy.

Foreign Body Localization

- In chest and abdomen when other traditional imaging techniques provide insufficient information.

ACKNOWLEDGMENT

The Society is greatly indebted to Dr. Peter Livingston, Hollywood Memorial Hospital, Florida for his input and Joan Collie for her assistance in manuscript preparation.

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Mayo Clinic

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APPENDIX E

Course Plan for the Inservice Class on Whole-Body CT Scanners

CONTINUING HEALTH EDUCATION FOR PHYSICIANS

1. SUBJECT TO BE PRESENTED:

a. Clinical applications and efficiency of whole-body CT scans.

b. Date of presentation - 25 March 1980

2. STATEMENT OF SPECIFIC OBJECTIVE:

(Statement of specific objectives should address what individual should achieve, i.e., (a) positive changes in attitude and approach of the learner to the solution of medical problems (b) correction of outdated knowledge and facts (c) implications of new information in specific areas (d) the introduction to and/or mastery of specific new skills and techniques; and (e) altering the habit patterns of physicians).

Individuals should receive information on current, state-of-the-art capabilities of whole-body CT scanners, an increased appreciation of how a CT scanner will impact in their area of specialization; and an increased awareness of medical conditions that could prompt the use of a CT scanner.

3. AGENDA: (Major sub-topics to be covered).

Current clinical applications of CT scanners.

4. LENGTH OF INSTRUCTIONS:

Approximately two hours.

5. INSTRUCTOR(S) AND QUALIFICATIONS:

Instructors will be six representatives of General Electric Corporation who have received special training in the capabilities of CT scanners. Primary instructor will be Dr. Alan Williams, assistant professor of Radiology, Medical College of Wisconson.

6. METHOD OF INSTRUCTIONS: (lecture, seminar, etc.).

Lecture

7. AUDIO VISUAL REQUIREMENTS:

Carousel projector and overhead projector.

8. EVALUATION METHOD(S):

Examples are pre- and post- program testing, questionnaire, and improved patient care as reflected in audits. This block must clearly implicate the evaluation method.

Qustionnaire (see attachment)

9. SPONSOR: MEDDAC, Fort Hood, Texas.

10. CO-SPONSOR: OTSG.

IF ADDITIONAL SPACE IS NEEDED, CONTINUE ON AN ATTACHED SHEET.

CT SCANNER LECTURE EVALUATION

1. Do you feel that this lecture contributed to your knowledge of CT Scanning? If yes, please specify.

- yes.
- Concise, knowledgable, presentation.

2. Would you like additional classes similar to this one?

Depending on the subject .. yes!

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Dept of Radiology
Darnall A.C. Hosp.

25 - March - 1980.

APPENDIX F

Analysis of Workload Data Survey
(Category of Patient by Clinical Service)

Analysis of Workload Data Survey

(Category of Patient by Clinical Service)

	January				February				March				April				
Service	Inp	Outp	Und	Tot	Inp	Outp	Und	Tot	Inp	Outp	Und	Tot	Inp	Outp	Und	Tot	Grand Total
Surgery	16			16	17	1		18	27			27				0[2]	61
Neurology				0[1]	1	40		41	2	58		60	2	33		35	136
Psychiatry				0[1]	1			1	2			2	2			2	5
Pediatrics				0[1]		6		6		1	2	3		10		10	19
Internal Med				0[1]		2		2		1		1		1		1	4
Urology				0[1]						1		1	5	2		7	8
Orthopedics				0[1]													
Emergency Med				0[1]													
OB-Gyn				0[1]													
Ophthalmology				0[1]													
Total	16			16	19	49		68	31	61	2	94	9	46		55	233

1. Did not begin survey data until February *Inpatient (Inp); Outpatient (Outp); Undetermined (Und)
2. Did not conduct survey in April

APPENDIX G

Analysis of Workload Data Survey
(Head Scan vs Body Scan by Clinical Service)

Analysis of Workload Data Survey

(Head Scan vs Body Scan by Clinical Service)

	January		February		March		April		Grand Total	
Service	Head	Body	Head	Body	Head	Body	Head	Body	Head	Body
Surgery	16		15	3	26	1			57	4
Neurology			41		60		35		136	
Psychiatry			1		2		2		5	
Pediatrics			6		3		10		19	
Internal Med			2		1			1	3	1
Urology						1		7		8
Orthopedics										
Emergency Med										
OB-Gyn.										
Ophthalmology										
Total	16		65	3	92	2	47	8	220	13

APPENDIX H

Report of Radiology Consultant Visit

BROOKE ARMY MEDICAL CENTER
Fort Sam Houston, TX 78234

Professional Consultant Trip Report, Brooke Army Health Services Region

1. Facility visited: Darnall Army Community Hospital, Fort Hood, TX

2. Date of visit: 20 February 1980

3. Key Personnel Contacted: COL William Winkler, MC, Commander; LTC William Yoder, MSC, Chief of Logistics; 1LT Paul Ferrell, MSC, MISO; Drs. George Rodgers and Nick Jackson, Contract Radiologists; CWO Leo Gehring, Chief, BMER; SSG Robert Poland, NCOIC, Department of Radiology; and SGT Rowden, BMER.

4. The visit included an entrance and exit briefing with the Commander and conferences with key personnel.

5. Findings and Recommendations:

a. The initial meeting consisted of a demonstration of a computerized data and image storing system created by 1LT Ferrell. The quality of the images was surprisingly excellent. This was especially true of bony structures, however, the soft tissues, particularly of the extremities, left something to be desired. I am not convinced as yet that the entire system as conceptualized will be practical. However, the entire concept is very exciting and I am convinced that, at least, portions, if not all, of the project will prove to be very valuable. For this reason, I strongly recommend further encouragement and research support of 1LT Ferrell's efforts.

b. A tour of the Radiology Department revealed no significant changes in equipment when compared with the previous consultant visit of October 1978, except for the addition of an ultrasound unit which happens to be very busy. There are still five radiographic rooms with two RF rooms, one chest room and two general radiographic rooms. The RF equipment remains borderline satisfactory with the best machine being a seven year old General Electric and the other RF room being a four year old CGR room which is down approximately 20 per cent of the time and produces a poor image when operating.

c. The equipment being evaluated for installation in the Fort Hood expansion project was reviewed. I concurred with all of the recommendations as planned with two exceptions:

(1) Fort Hood should have polytomographic capability which could be installed in place of one of the four projected general diagnostic rooms. Recommend sole source justification for the Phillips unit.

(2) Fort Hood should also have in-house CT capability (whole body unit) in light of their workload and relative remoteness.

d. Every effort should be made to standardize the equipment as much as possible and to purchase this large quantity of equipment from a reputable manufacturer with a proven track record for performance and service in the region. Unfortunately, the low bidders do not always perform satisfactorily.

e. Unfortunately, Fort Hood's request for a NRC license for Nuclear Medicine has been turned down, chiefly because of the lack of a RPO. If one cannot be provided through Army channels, strongly recommend considering contracting this service with a civilian organization in the area.

f. The lack of a sufficient number of technicians (only 14 out of 22 authorized positions filled) continues to be a problem. Unfortunately, this problem is Army-wide and there doesn't appear to be any immediate solution.

g. We met with CWO Leo Gehring and SGT Rowden from BMER. I was very impressed with their general attitude and was advised by SSG Poland that they had been doing an excellent job in support of Radiology. However, further training is needed of their technicians in the newer equipment and should be arranged if and when TDY funds again become available.

h. I spoke with George Rodgers, M.D., who is one of the two contract radiologists presently working at Fort Hood. He indicated a desire to join the Army. However, he is of the impression (hopefully, mistaken impression) that he could not join because of hypertension. Every effort should be made to recruit this fine individual and, if not for active duty, he certainly should be considered for a Civil Service position.

i. A current problem in the Department is in the actual ordering of radiographs. The SF519 is frequently inadequately completed and filled out by a non-physician or by a non-allied professional. The Joint Commission on Hospital Accreditation states that only physicians or persons specifically authorized by the hospital be allowed to order x-rays (page 157 of the latest Manual). This subject is drawing a lot of attention recently from the Joint Commission as well as appropriate government agencies.

5. Conclusion:

The radiology service provided at Fort Hood appears to be excellent in spite of very significant problems. This is a credit to the outstanding leadership and motivation of the enlisted staff, particularly SSG Poland, as well as the excellent contract radiologists.

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